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Integration of Information Technology in Science Education at Yanbu, Kingdom of Saudi Arabia

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Abstract

This chapter examined the level of information technology (IT) integration in science education at Yanbu district, Saudi Arabia. Both male and female science teachers at the elementary, middle, and high school levels in Yanbu education district, Saudi Arabia were asked about their use of IT in the classroom. This chapter is a survey which determined demographic data and level of technology implementation, personal computer use, and current instructional practice. The relationship of demographic information and science teachers' computer experience to their attitudes toward computers was also determined.

The mean frequency of IT use was 1-2 times during a semester. Regression analysis showed that locations, level of training, teaching experience, and gender significantly predicted frequency of computer use ($F_{(3,168)} = 3.63$, $R2 = .10$, $p<.014$). Teachers who received in-service training programs used IT significantly more frequently than those who did not receive any training ($t = 2.41$, $p = 0.017$). Teachers who received both pre-service and in-service trainings used IT significantly more frequently than those who did not receive any training ($t = 2.61$, $p = 0.01$). Low technology users perceived that there was no support or incentives for using technology while high technology users did not perceive these barriers ($r = -0.18$, $p =.01$). High technology users had positive personal beliefs about how IT benefits learning while low technology users held negative beliefs about technology use ($r = -0.20$, $p = .003$).

1. Introduction and Related Research

An Information Technology is becoming increasingly important in today`s modern world. Educators are aware that it is already an important force in modern education. However, there have been debates and discussions about the effects of using IT in schools in U.S. education resources since 1960.

Some educational theorists are convinced that technology will significantly change every culture and revolutionize the education process. Some theorists think that technology and Internet are the enemies of culture and morality with negative impact on issues such as ethics. Other theorists, however, see IT as basically an additive to the existing culture. They believe that it will speed up the transmission of information in education but will not change the fundamental nature of the educational process.

We present outlines various investigations into the barriers that prevent effective use of information technology in science education in K-12 public schools in Saudi Arabia (SA). It specifically draws from the perspectives of science teachers as to the use of information technology were identified. Demographic data enabled description of science teacher based on similarities and differences of gender, location of the school, science teacher training, years of teaching experience, and age.

The global economy and the potential importance of Saudi Arabia in the world then after make a study of implementing information technology application in Saudi Arabia very relevant. Very little prior research has been done in this area.

In 2001, a U.S. report of a National Centre for Educational Statistics survey by the (Corbin, 2003) revealed that *"99 percent of full-time regular public school teachers"* have access to computers connected to the Internet. This, contrasted with the limited computer and Internet access available in Saudi Arabian schools, demonstrates a wide gap between the availability of computers for use by teachers in the US and in Saudi Arabia.

The Author (Al-Oteawi, S. M, 2002) called attention to the importance of inclusion in successful technology integration. He underscored the fact that a well-developed program of staff development was critical to achieving successful implementation of computer use in the classroom. He strongly emphasized that everyone must be involved in technology integration-- teachers, principals, administrators, students, supervisors, and parents.

The author (Saman B.S, 2003) stated that some educators argue that computers are the solution to many educational problems. Other educators, however, strongly disagree with the advocates of applying IT to education, prophesising that learners will be harmed by applying these technologies to educational practice.

Examples of common uses of IT today are email and the worldwide web. The author (Zakaria, Z.,2001) stated that the potential of the powerful effect of IT is known in every field today. *"These days, information technology has become an active part of education and the electronic classroom has evolved. Computers are found in schools and a college, as computer literacy becomes a requirement for graduation"*. The integration of IT, like any pervasive change in the status quo, requires a period of adaptation for the persons involved. As Saudi Arabian educators and probably all educators wrestle with the problem of successful implementation, it is useful to consider IT as an instrument of change.

The author (Al-Oteawi, S. M, 2002) stressed the importance of successful technology integration. He underlined the fact that a well-developed staff development program is critical to achieving successful implementation of computer use in the classroom. He strongly emphasized that everyone must be involved in technology integration - teachers, principals, administrators, students, supervisors, and parents.

The author (Cuban, L., 2001) has contributed a great deal to the argument for caution in the adoption of computer technology in schools, indicating that a leading cause of unsuccessful technology integration is the failure of the technology selected for not taking into account the true and unique needs of teachers or their classrooms in teacher training programs.

Poorly conceived and uncoordinated attempt to provide technology to schools is likely to be unsuccessful.

The author (Corbin, J.F., 2003) concluded that the average learner takes 30 hours or more of contact time with a computer to become reasonably proficient with it for personal use; that is, basic word processing, email, and others. On the other hand, it takes more time to adopt other technology applications when adding video to a Power Point presentation or incorporating a digital camera, colour printer, and CD burner into a computer system.

The author (Zakaria, Z., 2001) argued for considerable training and a variety of training resources for educators to facilitate successful implementation of technology. He placed particular emphasis on the amount of time it would realistically take to integrate technology. Rogers (1995) found that 25 years was the typical time interval required to integrate technology. The author (Zakaria, Z., 2001) confirmed that "*a considerable time lag was required for the widespread adoption of new educational ideas*".

A consistent theme in the literature on integration of technology within education is the importance of school administrators. The author (Al-Oteawi, S. M, 2002) asserted that successful innovation and implementation of IT in teaching and learning depends on administrators' discussion with the teachers. The author (Al-Oteawi, S. M, 2002) concurred his work with the role principals play is the keystone to school reform. Administrators must be leaders of change in bringing new innovations and managing their powerful processes for reconstructing schools and in motivating teachers to improve their capabilities through staff development.

By drawing on graduate studies, as well as personal experiences as a teacher, administrator, senior supervisor, and student of educational technology, information technology is, indeed, changing the educational process and will continue to do so. Moreover, it is believed that IT produces profound effects on the educational process and has become part of the learning process for many.

To be comparable to industrialized nations, high-speed Internet connections are needed to fulfil basic educational needs. Up-to-date computers and peripheral devices should be provided in considerable number to education districts, schools, classrooms, science laboratories, halls, student activity centre offices, and resource centres. Teams of experts in the fields of IT, science curriculum, and computer science should meet together and work to build an interactive science curriculum to use with the computers in classrooms and laboratories. The curriculum must be created using the Arabic Language and include lesson plans, activities, assessments, tests, exams, administrative tools, and others that help science teachers teach with it successfully. In addition to the curriculum, guidance in the form of instructions and help menus should be built to answer any questions that teachers may have about the application or integration of IT. A help desk, hotline support by phone or live chat, and on-site support should also be provided to assist teachers in a timely way.

An important question then merits an investigation. We provide the answer of the following questions which are extending the IT adoption in Saudi science instruction. Below are the questions which we tried to solve in this paper.

1. To what extent do Saudi Arabia's science teachers integrate IT in their classroom teaching?; and
2. Which demographic variables (gender, location of the school, science teacher's training, years of experience, and/or age) are related to the use of IT?

The paper examined the degree of use of information technology in teaching science. It also identified the factors that are related to the use of information technology.

The paper is an organized as follows. In Section 2 we introduce our methodology which provides procedure to collect our data and shows the findings regarding IT integration in Yanbu. In Section 3 we present results and discussions. In Section 4 we present the limitation of our analysis method. Finally we summarize the paper with future discussion and recommendations.

2. Methodology

The research instrument was developed to replicate this study at future time intervals to establish longitudinal data in order to monitor trends and the degree of the technology use in Saudi Arabia over a period of time. Based on the findings from a preliminary focus group of 80 science teachers in Saudi Arabia, common barriers to IT adoption were identified and used to design the survey instrument.

2.1 Variables

The dependent variables included the degree and frequency of technology use. The scored measures of respondents' frequency and duration of sustained IT activities were used.

The demographic variables include school location, gender, years of teaching experience, pre-service IT training, in-service IT training, and age. Barriers were grouped into four categories. Each category contained statements to test the frequency of the science teachers' responses and determine whether or not it should be considered a barrier. The four groups were infrastructure and resources, policy and support, science teachers' personal beliefs, and staff development. Participants were asked to add any other barriers they considered important that were not mentioned in the instrument.

2.2 Survey Instrument

The survey instrument consisted of two main parts - technology use and demographic factors. The first part of the instrument focused on the degree and frequency of technology use based on four responses: not familiar, entry, adaptation, and transformation are listed in Table 1.

Option	Value	Description
Not Familiar	0	You don't use it all
Entry	1	You are just beginning to learn the basic skills and are aware of possibilities, but you do not use often in your teaching practice
Adaption	2	You are familiar with variety of uses of this, and often use it to support your existing classroom practices and teaching strategies
Transformation	3	Use of this tool has significantly changed your classroom practice; because of it you have crafted new curricula and new teaching and learning techniques

Table 1. Technology Adoption Scale

On the frequency of participants' use of technology, the teachers responded based on the options which are listed in Table 2. Duration or how long activities had been done by the participants was captured by asking the number of years they had been involved with the particular technology-related activity. The second part of the survey contained demographic information such as schools' location, gender, years of teaching experience, training, age, grade levels taught, number of classes taught weekly, highest educational degree and year earned, presence of a computer in their home or school, where computers were used (at home or school), where access to the Internet was available (at home or school), and number of computers available in teachers' classrooms and in computer laboratories in schools.

Description	Value
Never use the technology for this activity	0
Use the technology 1-2 times during the semester	1
Use the technology 1-2 times per month	2
Use the technology 1-2 times per week	3
Use the technology 3 times or more per week	4

Table 2. Frequency of Technology Use Scale

2.3 Participant Sample

The respondents or participants consisted of science teachers from Yanbu education district in Saudi Arabia during the School Year 2003-2004. According to the Department of Statistics (2003), there were a total of 284 science teachers in grades K-12. Survey questionnaires were sent to all schools at the Yanbu education district and distributed by the educational training department to all male and female science teachers who volunteered to participate in the study. About 176 questionnaires were returned by 105 male and 71 female science teachers, constituting 60 percent and 40 percent of those solicited, respectively.

2.4 Analytical Procedures

Descriptive statistics were used to know the extent the science teachers integrate IT in classroom teaching. The scale of the frequencies was from zero (never use) to 4 (use 3 times or more per week). The mean frequency of use for each teaching-related activity studied was sorted in descending order to examine the most frequent and least frequent use of technology shown in Table 3.

Teaching Activity	Mean IT Use	Std. Dev
To gather information for planning lessons	1.97	1.34
To create instructional material	1.57	1.15
To do administrative record keeping	1.57	1.53
To access model lesson plan	1.56	1.53
To access information and research best practices for teaching	1.47	1.20
To learn about computers and/or improve your computer skills	1.31	1.29
To communication between colleagues and/or professionals	1.16	1.29
To create multimedia presentations for classroom	0.98	1.19
To communicate with students' parents	0.73	1.05
To communicate with students outside of class hours	0.67	1.16
To post homework or other class requirements, project information or suggestions	0.43	0.89
To post share student work on the web	0.10	0.46

Table 3. Teaching Activities in order by highest Mean of IT Use

Regression analysis was used to ascertain the effect of school location, gender, teaching experience, and age on IT use. Since the goal was not to develop a predictive regression model but to develop a reasonable descriptive regression model to show the differences in associations between dependent and independent variables, the model was not refined to the degree of total parsimony. We used dummy variables for location, gender, and training were used. Gender was coded 1 = female, 0 = otherwise; location was coded as 1 = urban, 0 = otherwise; and 1 = suburban, 0 = otherwise. When both variables were coded 0 for otherwise, the variable was interpreted as "*industrial*". Lastly, training was coded as 1 = pre-service, 0 = otherwise; 1 = in-service, 0 = otherwise; and 1= both, 0 = otherwise. The implied reference was "*none*" when all explicit variables were set to 0. Before interpreting the findings, the regression model was tested for a multi-co-linearity problem. Co- linearity diagnostics of models were developed and the models were refined to eliminate this problem. The age variable was removed from the final model to ensure that the model would be stable enough to be able to interpret the contributions of each variable. Only four independent variables remained in the final regression model: location, gender, teaching experience, and training. Table 4 illustrates the descriptive statistics associated with those variables.

The partial correlation is the correlation of a given independent variable with the dependent variable, controlling for other independent variables in the model. The partial correlation removes the effect of the control variables on both the dependent and the independent variables. In contrast, in part correlation, the effect of the control variables is removed on the independent variable alone. So, the part correlation was used to assess the unique effect of the independent variable on the dependent variable.

Variable	Intercorrellation								
	Mean	SD	IND	PRE	INS	BTH	SEX	EXP	IT
Independent Variables									
Industrial (INS)	.21	.41							
Suburban(SUB)	.31	.46	-.34*						
Pre-Service Training (PRE)	.15	.36	.01	.13*					
In-Service Training (INS)	.34	.48	.10	.04	-.31*				
Both (BTH)	.15	.36	-.14*	-.04	-.18*	-.31*			
Gender (SEX)	.40	.49	.14*	-.05	.13*	-.20*	-.16*		
Teaching Experience (EXP)	7.14	4.93	.15*	-.41	-.19*	.04	.05	.19*	
Dependant Variable									
Frequency of IT Use (IT)	1.13	.78	.11	.02	-.10	.17*	.13*	-.11	-.07

Table 4. Descriptive Statistics and Intercorellation Matrix with relation to Mean Frequency Use of IT
*Significant at .05 level of significance

3. Results and Discussions

We present the first experimental results which examined the level of Information Technology integration in science education in Yanbu School. We have taken data from all teachers who were available at their respective campuses. We collected data which determined demographic information of science teachers. We find the following factors Frequency of IT use and the factors impacts which are affecting the IT use that are concerned with the collected data.

3.1 Frequency of Information Technology (IT) Use
The mean frequency of use for all educational activities was 1.13 with a standard deviation of 0.78. The frequency of IT use for all education activities averaged at 1-2 times during a semester. The maximum average frequency of use was reported at 3.25. However, most of the science teacher-respondents did not integrate IT into their classroom teaching at all. In the Figure 1 shows the frequency of IT use by science teachers in the Yanbu school district. Three activities representing the most frequent uses of IT:
1.   To gather information for planning lessons(Mean = 1.97);
2.   To create instructional materials (Mean = 1.57); and
3.   To do administrative record keeping (Mean = 1.57).
In Figure 1. there are three activities in which the least frequent uses of IT occurred were:
1.   To communicate with students outside of classroom hours (Mean = 0.67);
2.   To post homework or other class requirements, project information or suggestions (Mean = 0.43); and
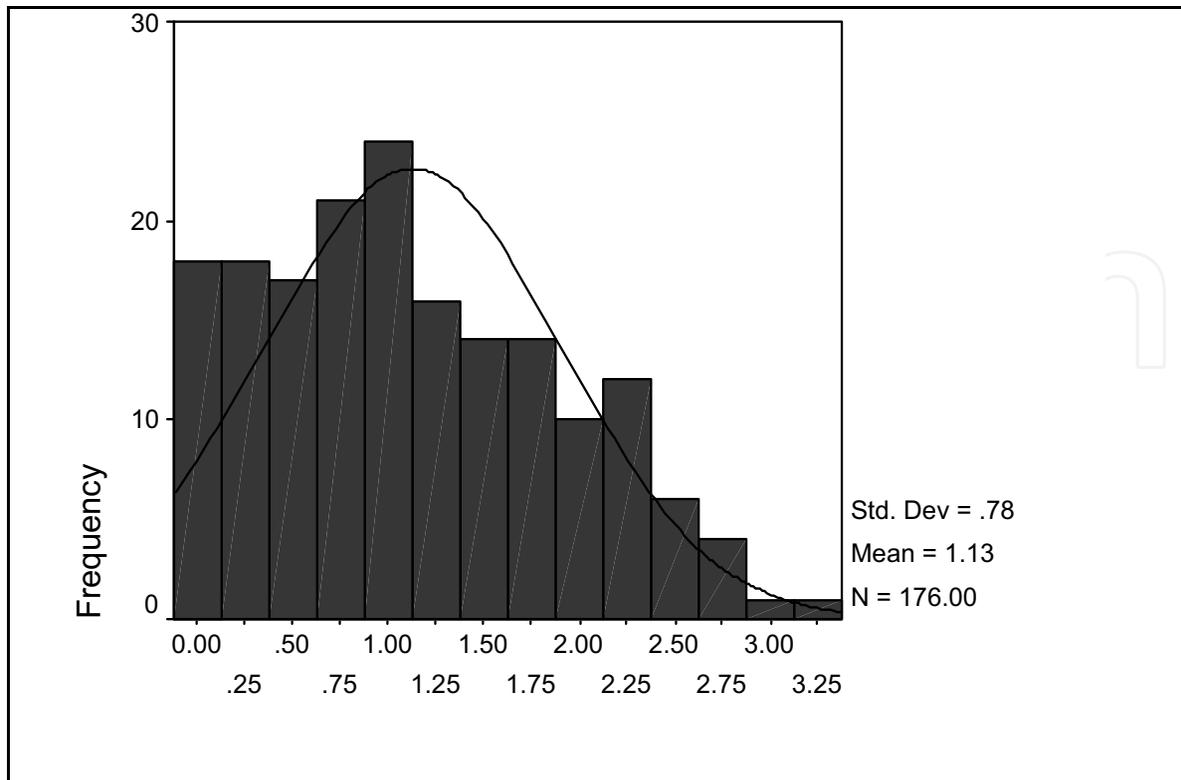3.   To post/share students work on the Web (Mean = 0.10).

Fig. 1. Distribution of the Frequency of an Information Technology (IT) Use

The above three activities in which the least frequent uses of IT occurred were:
4.   To communicate with students outside of classroom hours (Mean = 0.67);
5.   To post homework or other class requirements, project information or suggestions (Mean = 0.43); and
6.   To post/share students work on the Web (Mean = 0.10).

3.2 Factors Affecting the Frequency of IT Use

Table 5 shows that there was only one variable significant in the model. When the variable of training experience was entered into the last step, the new model explained 9.5 percent of the total variation in the frequency of IT use for all educational activities. The change of R-squared due to the addition of the training variable is equal to 5.9 percent with $F(3,168)=$ 3.63 and p = .014. This means that while controlling for other variables, the training variables contributed significantly toward explaining the total variance of the mean of frequency of use for all educational activities. In other words, the mean frequency of IT use for all educational activities differed with training experience.

In the last model in the ANOVA (Analysis Of Variance) associated with the regression, the value of F (7,168) was equal to 2.52 at p = .017. This means that the fourth model is the only one that is statistically significant in relation to the dependent variable. However, the statistical significance of the model in general does not guarantee that every variable significantly contributes towards predicting the dependent variable. It means that this model can be used to predict the dependent variable better than the average of that variable. It tells nothing about the quality of the prediction. In conclusion, this model may not

provide a good estimate or prediction for the dependent variable. Moreover, other independent variables that were not included in this study may contribute to a better model.

	B	SE B	β-wt p	R	R2	p	R2Δ
Step 1							
Industrial	.26	.15	.14	.13	.02	.222	.02
Suburban	.12	.13	.07	F(2,173) = 1.52			
Step 2							
Industrial	.30	.15	.16	.19	.03	.083	.02
Suburban	.12	.13	.07	F(1,172) = 3.05			
Gender	-.21	.12	-.13				
Step 3							
Industrial	.30	.15	.16	.19	.04	.563	.00
Suburban	.09	.14	.05	F(1,171) = .337			
Gender	-.20	.13	-.12				
Teaching experience	-.01	.01	-.05				
Step 4							
Industrial	.30	.15	.16	.31	.10	.014*	.06
Suburban	.07	.14	.04	F(3,168) = 3.63			
Gender	-.06	.13	-.04				
Teaching experience	-.02	.01	-.09				
Pre-service training	-.03	.18	-.01				
In-service training	.34	.14	.21*				
Both	.47	.18	.22*				

Table 5. Regression Model Describing Relationships between Location, Gender, Teaching Experience, IT Training and Frequency of IT Use in Science Education
*Significant at .05 level of significance

The frequency of IT use for all educational activities for the default location (urban) is equal to 0.993. For the industrial location, the frequency of IT use increases on average by 0.297 compared to the reference location (urban.) However, this difference was found not statistically significant (p > .05).

The "suburban" location was greater than "urban" by 0.07 in terms of mean frequency of IT use with a t-test value of 0.483 (p > .05). Since both increases in mean frequency uses in industrial and suburban locations compared with urban were not statistically significant, therefore, there is no significant difference between different types of location in terms of influence on the frequency of IT use. With all other variables controlled, female science teachers used IT less frequently than male science teachers at an average 0.0655. However,

the t-test for this difference is equal to -0.48 with p-value of .631. This means that, controlling all other variables, the difference in mean frequency of IT use between males and females is not significant. The regression coefficient of years of experience is equal to -0.02 which means that for every one year increase in teaching experience, the frequency of IT use decreases by 0.02. However, this was found not statistically significant ($p > .05$).

With all other variables controlled, teachers who received pre-service training programs used IT less than those who did not receive any type of training programs by 0.025. This was found not significant; hence, there is no significant difference between the frequency of IT use of teachers who received pre-service training programs and those who did not receive any type of training programs. In contrast, teachers who received in-service training programs used IT more frequently than those who did not receive any type of training programs by 0.343 ($p > .05$). With all other variables controlled, the teachers who received both types of training programs used IT more frequently than those who did not receive any type of training programs. The difference of 0.467 was found to be significant ($p < .05$).

The difference in the frequency of IT use between the teachers who received both types of training and those who received only in-service training can be calculated by subtracting the values of the two coefficients. So, the mean frequency of IT use for the teachers who received both types of training is greater than for those who received only the in-service training by 0.124. Both the partial and part correlations showed that the variables most highly correlated with the dependent variable were: both, in-service, and industrial. The contributions of the first two were significant while the contribution of the third variable was not, although it was nearly significant.

The tolerance statistic for any variable is equal to 1-R2 for the regression of that variable on all the other independent variables ignoring the dependent variable. If the tolerance is very close to zero, this means that there is a multicollinearity problem with that variable. All of the tolerance statistics of all independent variables are high, so there is no multicollinearity problem with any of them. This means that the coefficients of all independent variables will not face severe problems making them unstable. The variance inflation factor (VIF) is simply the reciprocal of tolerance. None of the independent variables have high values of VIF, which implies that there is no multicollinearity problem in this model.

By using the values of the standardized coefficients, the different variables might be ordered by contribution value as follows: both (0.218), in-service (0.211), and industrial (0.157) sequentially. While the contributions of the first two variables are significant, the third is not.

4. Limitations

This study was focused only on science teachers covering Academic Year 2003-2004. Aspects of IT implementation can change over time. Based on the continuous evolutionary development of the computer industry, the degree of technology use this year may be different from that of next year. This work is limited to a specific region in Saudi Arabia, the Yanbu district. It is hoped that these results could be generalized due to the inclusion of feedback from across Saudi Arabia which was used in the development of the survey instrument. However, one limiting factor of this research is that the results may not be generalized to non-science teachers. The barriers to the application of IT in other fields may be different from those in the field of science.

5. Conclusion and Future Research

To integrate IT more effectively into science education, policy makers in the Ministry of Education and in the education districts should provide more staff development for science teachers. Care should be taken to ensure the high quality of training programs that also serve as practical examples of technology-enhanced learning and learning-by-doing. Teachers experiencing quality training through the eyes of the student, in addition to learning technical skills, will promote integration of IT into science education in Saudi Arabia. Pre-service and in-service training need to be integrated into a goal-oriented, complementary, and reinforcing sequence to optimize teacher time and help them build competence and confidence in integrating IT into the classroom.

Based on the findings of our study, the literature review, and the experiences of other countries in integrating IT into education, development of a three-part strategic plan by the Ministry of Education, supported by the educational districts, is recommended. The macro-component would define a national IT adoption plan with respect to education districts, schools, colleges, universities, and other government agencies. The micro component of the strategic plan would define domain-specific plans, such as a school IT plan, to deal with particular needs of K-12 schools. Initial focus should be on infrastructure and resources as this domain was considered by the participants of this study to be the dominant barrier to the integration of IT into science education in Saudi Arabia. To build the basic infrastructure, all classrooms, science laboratories, halls, offices, and resources centres should be connected to each other through a computer network and all connected to the Internet and to the school districts and the Ministry of Education. Access to centralized services can be customized based on the authorities of every user on the network.

Staff development is a key to successful integration of IT. This paper showed that in-service training increases the use of IT by science teachers. While science teachers may represent the early adopters of technology, learning and using computers at home, other teachers may be less likely to learn or use these technologies on their own.

Future work can be the following steps. The lack of time is an important factor affecting the application of IT in Saudi Arabia . In Saudi Arabia's educational system, teachers work from about 7:00 a.m. until 2:00 p.m. The overall mean number of class sessions taught by science teacher participants was 18 per week. Because of this busy schedule, both teachers and students have a limited number of hours during the day to work on integrating IT into science education.

The author (Zakria, Z. 2001) argued the need for time to realistically integrate technology. The author (Corbin, J. F, 2003) addressed the importance of time for the teachers to learn IT and suggested that 30 or more hours of contact time with a computer is necessary to become reasonably proficient with it for basic use. Lack of time was also one of the barriers identified by (BECTA 2004) who gathered data from 170 teachers through an online questionnaire.

It is not just science teachers who need training in IT to enable its integration into the science curriculum. The Author (Aldawood, A., 2000) concluded that educational administrative professionals and their attitudes towards computers are also important. Attitudes of principals who had accomplished many hours of training on microcomputer use were more positive than the attitudes of those principals who have had few or no hours of computer training. In addition, the attitudes of principals who owned computers were more positive than the attitudes of those principals who did not own computers.

6. Acknowledgment

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Technology Education and Development
Edited by Aleksandar Lazinica and Carlos Calafate

The widespread deployment and use of Information Technologies (IT) has paved the way for change in many fields of our societies. The Internet, mobile computing, social networks and many other advances in human communications have become essential to promote and boost education, technology and industry. On the education side, the new challenges related with the integration of IT technologies into all aspects of learning require revising the traditional educational paradigms that have prevailed for the last centuries. Additionally, the globalization of education and student mobility requirements are favoring a fluid interchange of tools, methodologies and evaluation strategies, which promote innovation at an accelerated pace. Curricular revisions are also taking place to achieved a more specialized education that is able to responds to the society's requirements in terms of professional training. In this process, guaranteeing quality has also become a critical issue. On the industrial and technological side, the focus on ecological developments is essential to achieve a sustainable degree of prosperity, and all efforts to promote greener societies are welcome. In this book we gather knowledge and experiences of different authors on all these topics, hoping to offer the reader a wider view of the revolution taking place within and without our educational centers. In summary, we believe that this book makes an important contribution to the fields of education and technology in these times of great change, offering a mean for experts in the different areas to share valuable experiences and points of view that we hope are enriching to the reader. Enjoy the book!

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